Western Great Lakes Research Conference and Chequamegon Bay Area Natural Resource Conference

April 9-11, 2003

Agenda

April 9, 2003

1:00-1:15 p.m.	**Welcome and Registration**
1:15-1:45 p.m.	**National Park Stewardship and Vital Signs Monitoring** Gary Davis, Oceans Programs, National Park Service, Washington, D.C.
1:45-2:15 p.m.	**Potential Sources of Pesticides, PCBs, and PAHs to the Atmosphere of the Great Lakes** Will Hafner* and Ronald A. Hites, Environmental Science Research Center, Indiana University, Bloomington, IN
2:15-2:45 p.m.	**Spatial and Temporal Change in Surface Water Quality, Upper Great Lakes** David Toczydlowski*, Michigan Technological University, Houghton, MI and Robert Stottlemyer, USGS-BRD, Ft. Collins, CO
2:45-3:00 p.m.	**Break**
3:00-3:15 p.m.	**Monitoring Natural and Anthropogenic Change in the Grand Sable Dunes, Pictured Rocks National Lakeshore** Walter L. Loope, U.S. Geological Survey, Munising, MI
3:15-3:45 p.m.	**Restoration of Oak Island Sandscape, Apostle Islands National Lakeshore** Julie Van Stappen*, Apostle Islands National Lakeshore, Bayfield, WI; Tony Bush, Natural Resource Conservation Service, Oneida, WI; and Dave Burgdorf, Natural Resource Conservation Service, East Lansing, MI
3:45-4:15 p.m.	**Control of Purple Loosestrife at St. Croix National Scenic Riverway: A Question of Efficacy** Robin Maercklein, St. Croix National Scenic Riverway, St. Croix Falls, WI

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Agenda (continued)

April 10, 2003

8:30-8:45 a.m. **Welcome and Registration**

8:45-9:15 a.m. **Monitoring for Change in Plant Community Composition in Apostle Island Wetlands, 1996-2002**
James Meeker[1]*, Julie Van Stappen[2], and Kathryn Miller[1]; [1]Northland College, Ashland, WI, and [2]Apostle Islands National Lakeshore, Bayfield, WI

9:15-9:45 a.m. **Effects of Moose on Fuel Load in Isle Royale National Park Forests**
Ron Moen, Natural Resources Research Institute, University of Minnesota, Duluth, MN and Rolf Peterson, MTU, Houghton, MI

9:45-10:15 a.m. **Identifying Reference Conditions of Disturbed Ecosystems and Applications for Maintaining Openland Avian Diversity at Sleeping Bear Dunes National Lakeshore**
P. Charles Goebel*[1], R. Gregory Corace, III[2], and Thomas C. Wyse[1]; [1]Ohio State University, Wooster, OH and [2]Seney National Wildlife Refuge, Seney, MI

10:15-10:30 a.m. **Break**

10:30-11:00 a.m. **Spatially-Explicit Hierarchical Models of Avian Counts**
Melinda G. Knutson* and Wayne E. Thogmartin, U.S. Geological Survey, La Crosse, WI; John R. Sauer, U.S. Geological Survey, Laurel, MD

11:00-11:30 a.m. **Inventories of Amphibians and Turtles in the Upper Midwest via USGS's Amphibian Research and Monitoring Initiative and NPS's Inventory and Monitoring Program**
Walt Sadinski[1]* Mark Roth[1], Leah Monson[2], Tyler Fanta[2], and Sam Bourassa[2], [1]U.S. Geological Survey, La Crosse, WI and [2]University of Wisconsin, La Crosse, WI

11:30-12:00 p.m. **Searching for the Eastern Massasauga Rattlesnake at Indiana Dunes National Lakeshore**
Ralph Grundel and Gary Glowacki*, U.S. Geological Survey, Porter, IN

12:00-1:15 p.m. **Lunch** (on your own)

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1:15-1:45 p.m.	**The Ecological Legacy of Historically High White-tailed Deer Densities at Sleeping Bear Dunes National Lakeshore** David Flaspohler*, Audra Bassett, Peter Hurley, Justin Rosemier, and Brian Beachy, Michigan Technological University, Houghton, MI
1:45-2:15 p.m.	**Confirmation of a Resident Cougar at Sleeping Bear Dunes National Lakeshore in Northwest Michigan** Patrick J. Rusz, Ph.D., Michigan Wildlife Conservancy, Bath, MI
2:15-2:45 p.m.	**The Use of Computer Simulation Modeling as a Tool for Planning and Monitoring in Wilderness Management at Isle Royale National Park** Ann Mayo-Kiely*, Steve Lawson and Robert E. Manning, Isle Royale National Park, Houghton, MI
2:45-3:00 p.m.	**Break**
3:00-3:30 p.m.	**The Spread of Housing and the Wildland-Urban Interface (WUI) Around National Park Units in the Midwest USA** Peter Budde* and Kathie Hansen, National Park Service, Madison, WI; Roger Hammer, Department of Rural Sociology, University of Wisconsin, Madison, WI; Sherry Holcomb, Jason McKeefry, Volker Radeloff, and Adrian Treves, Department of Forest Ecology and Management, University of Wisconsin, Madison, WI; Susan Stewart, U.S. Forest Service, Evanston, IL
3:30-4:00 p.m.	**Zebra Mussels in Chequamegon Bay: the Evolution of Monitoring and Current Status** Gary D. Czypinski, U.S. Fish and Wildlife Service, Ashland, WI
4:00-4:30 p.m.	**Developing Indicators to Monitor Freshwater Wetlands** G.R. Guntenspergen*, U.S. Geological Survey, Patuxent Wildlife Research Center, Duluth, MN, and H. Neckles, Augusta, ME

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8:30-8:45 a.m.	**Welcome and Registration**
8:45-9:15 a.m.	**Evaluating Aircraft Mounted, Aerial Imaging Systems for Identifying Groundwater Sources** Lee Newman, U.S. Fish and Wildlife Service, Ashland, WI
9:15-9:45 a.m.	**Nine Years of Landscape-Level Research in Chequamegon National Forest** K.D. Brosofske*, U.S. Forest Service, Rhinelander, WI; J. Chen, Department of Earth, Ecological, and Environmental Sciences, University of Toledo, Toledo, OH; S.C. Saunders, School of Forest Resources and Environmental Management, Michigan Technological University, Houghton, MI; and T.R. Crow, U.S. Forest Service, Grand Rapids, MN
9:45-10:15 a.m.	**Landscape Dynamics and Disturbance in Chequamegon National Forest, Wisconsin, USA, from 1972-2001** Mary K. Bresee*, Jim Le Moine, Stephen Mather, Kimberley D. Brosofske, Jiquan Chen, and Thomas R. Crow, University of Toledo, Toledo, OH
10:15-10:30 a.m.	**Break**
10:30-11:00 a.m.	**Soil Respiration Trends Within and Among Stand Ages and Types in the Chequamegon National Forest** J.M. Le Moine and J. Chen, University of Toledo, Toledo, OH
11:00-11:30 a.m.	**Water Use Efficiency in a Managed Northern Wisconsin Landscape: Variation Among Ecosystems** Asko Noormets, Jiquan Chen, Thomas Crow, and Kimberley Brosofske; University of Toledo, Toledo, OH
11:30-12:00 p.m.	**Geomorphic Assessment for Stream Rehabilitation, Bayfield Peninsula, WI** Faith A. Fitzpatrick*, U.S. Geological Survey, Middleton, WI and Inter-Fluve Inc., Lake Mills, WI

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Poster Session

Diversity of Carabid Beetle Assemblages in Selected Habitat Types within Grand Portage National Monument
L. Suzanne Gucciardo, Grand Portage National Monument, Grand Portage, MN and David MacLean, Grand Marais, MN

A Population and Angler Use Assessment of Muskellunge in Shoepack Lake, Voyageurs National Park, Minnesota
Nick K. Frohnauer and Clay L. Pierce, Iowa Cooperative Fish and Wildlife Research Unit, Iowa State University, Ames, IA; Larry Kallemeyn, USGS-BRD, International Falls, MN

Recent Large Landslides in the Sleeping Bear Dunes National Lakeshore, Michigan
Bruce E Jaffe*[1], Rob E. Kayen[2], Walter A. Barnhardt[2], Tom E. Reiss[2], Guy R.Cochrane[2], Steve Yancho[3], and Max Holden[3]; [1]U.S. Geological Survey Pacific Science Center, University of California, Santa Cruz, CA,[2]U.S. Geological Survey, Menlo Park, CA, [3]Sleeping Bear Dunes National Lakeshore, Empire, MI

High-resolution Multibeam Sonar Mapping of Lake Trout Spawning and Nursery Habitat
Nigel Wattrus, University of Minnesota, Duluth, MN

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Landscape Dynamics and Disturbance in Chequamegon National Forest, Wisconsin, USA, from 1972 to 2001

Mary K. Bresee*, Jim Le Moine, Stephen Mather, Kimberley D. Brosofske, Jiquan Chen, and Thomas R. Crow, University of Toledo, 2801 W. Bancroft, Toledo, OH 42606 (bres9575@hotmail.com)

Fire suppression, corridor construction, silvicultural practices, and other disturbances are the primary forces of forest fragmentation in the Great Lakes Region. Our objectives were to: (1) assess changes and rates of change, through time, in vegetative composition and structure within Washburn Ranger District in Northern Wisconsin using Landsat images; (2) examine changes in landscape structure (e.g., edge length, patch size, etc.) through time; and (3) investigate changes in landscape composition and structure within the context of forest management activities. Satellite imagery and detailed field data provided a broad-scale characterization of landscape change between 1972 and 2001. Classifications included six dominant cover types in the landscape: mixed hardwood (MH), jack pine (JP), red pine (RP), mixed hardwood/conifer (MHC), non-forested bare ground (NFBG), and regenerating forest or shrub (RFS). Increases in NFBG and RFS, by 197.5% and 34.2% respectively, reflect expansion of the pine barrens ecosystem. Windthrow in the mature hardwoods during the late 1970s and jack pine budworm outbreaks during the mid-1990s are correlated with decreases in those classes over the corresponding intervals. A 46.3% decrease in mean patch size and an 18.6% increase in total edge length reflect increased fragmentation. An inverse relationship existed between the composition trends of forested (excluding jack pine) and the composition trends of RFS and NFBG cover types. Results from this study are key in assessing the links between management activities and ecological consequences and thereby facilitate adaptive management.

Nine Years of Landscape-Level Research in the Chequamegon National Forest

K.D. Brosofske*[1], J. Chen[2], S.C. Saunders[3], and T.R. Crow[4]
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[2]Dept. of Earth, Ecological, and Environmental Sciences, University of Toledo, Toledo, OH 43606
[3]School of Forest Resources & Environmental Science, Michigan Technological University, Houghton, MI 49931
[4]USDA Forest Service, North Central Research Station, 1831 Hwy 169E, Grand Rapids, MN 55744
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The Landscape Ecology and Ecosystem Science (LEES) lab at the University of Toledo (formerly at Michigan Tech University), in cooperation with the North Central Research Station of the U.S. Forest Service, has conducted research in the Washburn District of the Chequamegon National Forest since 1994. This presentation will outline the history of this research, present key themes and results, and introduce the current, ongoing research projects. The latter will be discussed in greater detail in separate presentations by other researchers from the LEES lab. The major theme of our research is to understand patterns and processes at different scales in a managed land mosaic using both field studies and modeling techniques. Particular emphasis has been placed on understory plant distribution and diversity, microclimate, decomposition, forest structure, and more recently, soil respiration and carbon and water flux. The original research project in 1994 examined the broad-scale effects of landscape structure on microclimate and understory plant distribution using 3 km transects placed within each of four management areas, including the Moquah pine barrens, a closed-canopy forest, and small-block and large-block timber harvesting units. This project was later expanded to focus explicitly on the effects on understory plants of particular landscape features: dominant patch types, unpaved forest roads, forest-clearcut edges, and small wetlands. Some of our major findings indicate that: (1) timber harvesting does not necessarily mimic fire in its effect on understory vegetation; (2) responses of understory plants to landscape structural features vary with scale; (3) roads, edges, and other small landscape features may have a disproportionate effect on understory plant diversity and microclimate; (4) temperature patterns are spatially and temporally dynamic; (5) patterns of functional environments (e.g., temperature and decomposition) do not necessarily parallel structural environments (and temperature-overstory relationships vary with scale); (6) soil and ecosystem carbon fluxes within dominant patch types are significantly different among temporal scales; and (7) the landscape is dominated by areas that are influenced by multiple edges, indicating a need for additional research on characterizing and predicting edge effects. Vegetation data have also been consolidated to develop a decision-support model that will predict plant diversity, recreational use, and economic output on the basis of the landscape

structure resulting from timber harvesting. Currently, our work in the Washburn District is directed toward quantifying net ecosystem exchange of carbon and water at the landscape level using mobile eddy-covariance systems placed within each of the dominant ecosystems. We have placed particular emphasis on age and successional differences in order to quantify the cumulative carbon flux of this disturbed landscape. Our focus on age structure is a unique aspect of this study. Within the scope of this project, we have examined landscape change over the past 30 years, water use efficiency, and soil respiration (results from which will be presented in greater detail by other presenters). In addition to work on ecosystem and landscape processes, future research will likely include further studies on biological diversity and landscape structure, including a focus on additional taxa (e.g., soil macroinvertebrates) and invasive species, as well as additional structural elements, particularly areas under multiple edge influences. We anticipate results would be used in developing management plans aimed at maintaining various functions of forests from ecosystem to landscape levels. We are interested in keeping our research relevant to managerial needs and therefore welcome cooperators from government agencies and other interested organizations.

The Spread of Housing and the Wildland-Urban Interface (WUI) Around National Park Units in the Midwest USA

Peter Budde*[1], Kathie Hansen[1], Roger Hammer[2], Sherry Holcomb[3], Jason McKeefry[3], Volker Radeloff[3], Susan Stewart[4], Adrian Treves[3]
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[3]Department of Forest Ecology and Management, 1630 Linden Dr., University of Wisconsin, Madison, WI 53706
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Housing density has increased dramatically in the USA over the past 60 years both from urban sprawl and development around bodies of water in more remote, rural areas. Rural housing development can fragment habitat, alter ecosystem function and threaten water quality. We quantified housing development over time to depict the resulting increase in wildland-urban interface (WUI) around a set of National Park units in Michigan, Minnesota, Missouri and Wisconsin, USA. To do so, we mapped 1990 and 2000 housing density at the census block level using US Census Bureau data, and tracked change from 1940-2000 at a coarser resolution (partial block group), based on the long form census question "When was this housing unit first built?" We integrated these data with park unit boundaries, land cover and housing density within a GIS framework. Our analyses and initial results suggest that national park units have effectively protected their associated bodies of water from the spread of rural housing. We describe how our maps can serve many stakeholders in planning and policy formulation. We discuss the ecosystem functions that may be compromised with the increase in wildland-urban interface around midwestern national park units and bodies of water.

Zebra Mussels in Chequamegon Bay: the Evolution of Monitoring and Current Status

Gary D. Czypinski*, U.S. Fish and Wildlife Service, 2800 Lakeshore Dr. E., Suite B, Ashland, WI 54806-2427
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Although a small dormant population already existed in Chequamegon Bay, the discovery of a zebra mussel *(Dreissenia polymorpha)* laden tugboat and barge overwintering in the bay in 1999 spread concern that a major infestation of zebra mussels had been introduced into Chequamegon Bay. A task force was quickly formed consisting initially of biologists and representatives from USFWS, USGS, BIA, NPS, WDNR, GLIFWC, and the Bad River Tribal Natural Resources Department (BRTNRD) to request the cleaning of the vessels, and develop a monitoring plan. During 1999, BRTNRD initiated monitoring by setting pvc pipes (2 inches in diameter x 12 inches in length, cut longitudinally in half and clamped together) at 14 locations, four in the Bad River and 10 on the periphery of tribal waters in the bay. No zebra mussels were collected. In 2000, BRTNRD set their pvc samplers in the same locations, and the USFWS-Ashland FRO set adult samplers (sandwiched plates separated by 1-inch spacers) at 20 locations along the city of Ashland shoreline from the Xcel power plant to the ore dock. Two or three laboratory slides were attached to the settling plate samplers to monitor for the presence of settled larvae. No zebra mussels or settled larvae were collected. In 2001, monitoring was expanded to the outer waters of Chequamegon Bay, including the Bayfield, Cornucopia, Sand Island, and Madeline Island marinas. One juvenile zebra mussel was collected from a settling plate located near the Xcel power plant. Water samples were also collected with a plankton net to detect for the presence of veligers. No veligers were detected. In 2002, underwater divers surveyed the periphery of the Xcel power plant and the Reiss coal dock. No zebra mussels were observed. In 2003, Ashland FRO plans to contract with an underwater diving team to survey for mussels in the Ashland harbor area. Any collected mussels will be laboratory tested for reproductive capacity.

National Park Stewardship and Vital Signs Monitoring

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Place-based conservation strategies require that stewards know and understand the targeted ecosystems, restore impaired resources, protect the ecosystems and mitigate threats to them, and connect people deeply to the ecosystems. These actions are the cornerstones of stewardship: know, restore, protect and connect. Knowledge of ecosystem structure and functioning is first among equals in stewardship. Monitoring the environmental equivalent of medical vital signs is the quickest, surest, and cheapest way to discover and track dynamic ecosystem structure and functioning. Monitoring vital signs can determine status and trends of ecosystem health, establish empirical limits of normal variation, provide early warnings of situations that require intervention, and help frame research questions to determine cause and consequence. The power and probabilistic nature of biological interactions in ecosystems preclude successful deterministic modeling to accurately predict system behavior. Knowledge of system dynamics requires ongoing monitoring. The National Park Service has begun to identify and monitor ecosystem vital signs in 32 networks of 270 parks. Eight of these networks include 64 ocean and coastal national parks, including the Great Lakes. The National Park Service is seeking opportunities to partner with other agencies and institutions in stewardship of coastal ocean ecosystems and monitoring the environmental vital signs of these ecosystems.

Geomorphic Assessment for Stream Rehabilitation, Bayfield Peninsula, Wisconsin

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Several tributaries to Lake Superior along the Bayfield Peninsula of Wisconsin supported large populations of brook trout *(Salvelinus fontinalis)* prior to European settlement and subsequent clear-cut logging in the late 1800s. These populations were thought to have occupied all reaches of the tributaries and near-shore areas of Lake Superior. Presently, only a handful of small headwater reaches support reproducing brook trout, even though the tributary watersheds have returned to mainly forested conditions. The U.S. Geological Survey, Trout Unlimited, Inter-Fluve, Inc., and the Wisconsin Department of Natural Resources are working cooperatively on a multi-spatial- and multi-temporal-scale assessment of historical and present-day geomorphic conditions, land cover, flooding characteristics, sediment sources, and ground-water-contributing areas for five tributaries in the Bayfield Peninsula: the Cranberry River, Bark River, Raspberry River, Sioux River, and Whittlesey Creek. A geographic information system is being used to compile watershed-level data on soils, elevation and slopes, 1928 and 1992-93 land-cover, drainage area, and geology. A base-flow survey of the tributaries and adjacent streams was conducted in November 2002 to identify reaches with significant regional ground-water contributions. These data, along with well logs, were used to develop a ground-water model of the peninsula. Longitudinal profiles of the streams from headwaters to Lake Superior were constructed to help identify reaches prone to erosion, sedimentation, or lateral migration. Watershed-wide geomorphic assessments of flood power and related channel and valley characteristics were conducted in each tributary during the summer and fall of 2002 to assess relative contributions to habitat degradation. Reach-scale geomorphic issues were also assessed and included bank and valley erosion, sedimentation, substrate conditions, local habitat quality, fish passage, and integrity of forest roads. The watershed-wide assessments will help in developing techniques to reduce flood power and sediment load throughout the five watersheds, whereas reach-scale assessments will help prioritize and locate sites for rehabilitation efforts. A rainfall-runoff model is being developed for the Cranberry River to assess flood characteristics. A temporal study of the long-term geomorphic processes operating in the Cranberry River also is being conducted. Erosion-control structures constructed in the late 1950s through present-day in the Whittlesey Creek basin and nearby areas are being evaluated. Results and recommendations from this cooperative study will help guide stream rehabilitation efforts geared toward protecting and enhancing brook trout habitat.

The Ecological Legacy of Historically High White-tailed Deer Densities at Sleeping Bear Dunes National Lakeshore

David Flaspohler*, Audra Bassett, Peter Hurley, Justin Rosemier, and Brian Beachy
School of Forest Resources and Environmental Science, Michigan Technological University, 1400 Townsend Dr., Houghton, MI 49931
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White-tailed deer have been shown to influence forest and understory plant community structure, particularly when they are maintained at high densities for a long period to time. However, the duration of browse-related forest disturbance has not been well studied. Within Sleeping Bear Dunes National Lakeshore, the beech-maple forests of North Manitou Island (NMI) and nearby South Manitou Island (SMI) have experienced dramatically different exposure to deer during the last 75 years. Deer were introduced to NMI prior to Federal ownership and maintained at high densities for several decades, while SMI has been a historically deer-free system. We examined several features of the two islands and the mainland likely to be influenced by current and historic levels of deer browse. On NMI, American beech *(Fagus grandifolia)* was far more dominant relative to the co-dominant sugar maple *(Acer saccharum)*. Canada yew *(Taxus canadensis)* has apparently been extirpated and several other tree species varied in their relative abundance. Predation rates by small mammals on artificial nests were higher on NMI than SMI, as were densities of eastern chipmunks. Several understory bird species also showed differences in relative abundance. These preliminary data suggest that long-term exposure to intense deer browsing may alter forest and vertebrate community structure for many years.

Identifying Reference Conditions of Disturbed Ecosystems and Applications for Maintaining Openland Avian Diversity at Sleeping Bear Dunes National Lakeshore

P. Charles Goebel*[1], R. Gregory Corace, III[2] and Thomas C. Wyse[1]
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One of the first steps in any successful forest ecosystem restoration program is the establishment of a set of reference conditions and a method to predict reference conditions for disturbed sites. We applied an integrated approach, often used in the development of ecosystem classification, which is based on the premise that geomorphology and soils can be used to predict reference or benchmark plant communities. Using spatial data on glacial geology and soils, we applied an existing hierarchical ecosystem classification system that is based on geomorphology, soils and relatively undisturbed vegetation for the nearby Huron-Manistee National Forest of northern Lower Michigan to identify potential reference plant communities for Sleeping Bear Dunes National Lakeshore. These data were then coupled with current land use-land cover data in a geographical information system to help identify target locations for forest ecosystem restoration efforts, as well as making generalized predictions about the successional trajectories and restoration potential of individual forest stands. We use this approach in conjunction with surveys of openland avian communities to identify specific “cultural landscapes” (i.e., complexes of abandoned historical farms in various stages of early succession from open pastures to scrub shrub) that should be maintained as openland habitat for many avian species of concern, or actively restored to a more natural forested condition.

Searching for the Eastern Massasauga Rattlesnake at Indiana Dunes National Lakeshore

Ralph Grundel and Gary Glowacki*, U.S. Geological Survey, 1100 N. Mineral Springs Road, Porter, IN 46304
(ralph_grundel@usgs.gov)

The Eastern Massasauga Rattlesnake *(Sistrurus catenatus catenatus)* is a candidate for listing as a federally endangered species. Once common at Indiana Dunes National Lakeshore, confirmed sightings in historic locales within the park have been lacking for more than a decade. We used three methods (drift fences, visual searches, and cover boards) at fourteen locations to search for Massasaugas in the park. One snake was captured in a drift fence after more than five months of continuous sampling. These results compare to dozens to hundreds of captures of other snake species during a concurrent study of the relationships between savanna structure, fire frequency, and amphibian and reptile abundance at Indiana Dunes.

Developing Indicators to Monitor Freshwater Wetlands

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The wetlands of Acadia National Park (Maine) are threatened by a suite of anthropogenic stresses associated with increasing visitor pressure and rapid residential development of watersheds adjacent to the park. A monitoring program is essential to help resource managers document trends in wetland condition, evaluate potential threats, and identify areas of management concern. We have conducted an initial project to select potential wetland monitoring variables by comparing candidate indicators among twenty wetlands of one type only, herbaceous emergent fens, along a gradient of ecological condition. Preliminary results show a set of chemical (conductivity and total nitrogen concentrations in pore water), physical (hydrologic fluctuations), and vegetation (presence and absence of moss species) indicators with promise for monitoring wetland integrity; i.e., in accordance with established guidelines for evaluating ecological indicators. The parameters are related to specific wetland functions, implementation appears feasible, and responses to stress are outside the range of natural variability. These results are applicable at other northern temperate freshwater wetlands.

Potential Sources of Pesticides, PCBs, and PAHs to the Atmosphere of the Great Lakes

Will Hafner* and Ronald A. Hites, Environmental Science Research Center, School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405
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Atmospheric transport has been shown to be an important pathway for the deposition of organic contaminants far from the original source region. A probabilistic model called the potential source contribution function (PSCF) has been used to estimate these atmospheric source regions of polycyclic aromatic hydrocarbons (PAHs), chlorinated pesticides, and polychlorinated biphenyls (PCBs) to the Great Lakes. We have applied the PSCF model to data from the five U.S. sites of the Integrated Atmospheric Deposition Network (IADN). Using this model on IADN's extensive data set has allowed us to map each compound's source region on a $0.5^{\circ} \times 0.5^{\circ}$ latitude/longitude grid centered over the Great Lakes basin. PCBs primarily have sources in urban areas, and atmospheric transport is strongly affected by air/water exchange with the Great Lakes. Like PCBs, PAH show a strong urban signature, but these compounds also seem to come from rural sites. The source regions of PAH become less distinct as the molecular weight of the compound increases. Since reactivity increases with PAH size, this diminishing trend may be an indication that atmospheric degradation plays a large role in PAH transport. The pesticides have the strongest source regions and are typically transported the farthest, often from areas distant from the Great Lakes basin.

Spatially-Explicit Hierarchical Models of Avian Counts

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Anticipating needs of high-priority species before they become threatened or endangered is more cost-effective than managing species after they are listed. Methods are now available to model and map expected abundances of high-priority bird species across large regions and GIS tools are available to help biologists incorporate such maps into conservation plans. The models and maps are valuable for identifying expected species of concern on specific National Parks and for planning monitoring and management activities that maximize benefits to multiple species. In addition, these maps provide a basis for forecasting bird responses to changes in habitat condition. We utilized a Markov Chain Monte Carlo (MCMC) approach to spatially predict abundance of 11 rare avian species in the Upper Midwestern U.S. The model is an overdispersed Poisson regression with fixed and random effects. North American Breeding Bird Survey counts over 21 years occur as a loglinear function of explanatory variables describing habitat, spatial relatedness, and nuisance effects (differences between observers). We also included a year effect to control for trends in counts over time. The model includes a conditional autoregressive term representing the correlation between adjacent routes. Explanatory habitat variables in the model included land cover composition and configuration, climate, terrain heterogeneity, and human influence. The model is hierarchical in that distributions of the data and parameters are described conditionally on realized values of parameters that are also random variables. Because there is no closed-form expression for such an approach, the model must be fitted by iterative simulation. The program WinBUGS conducts these MCMC iterative simulations. As an example of our work with this model, we mapped regional patterns in Cerulean Warbler *(Dendroica cerulea)* abundance based on a model containing the percentage of woody wetlands, an index of wetness potential, and the interaction of annual precipitation and deciduous forest patch size. The Cerulean Warbler is among the highest priority of land birds for conservation in the eastern United States. We concluded Cerulean Warblers are most abundant in dry areas within moist forested landscapes, with their sensitivity to forest patch size modified by regional gradients in precipitation. This species is most abundant in the largest forests where precipitation is greatest. This model explained 32% of the variation in Cerulean counts, a sizable portion given that specific site-level habitat information (e.g., canopy cover, understory stem density) was not represented in the model. Our work furthers the objectives of national interagency bird conservation initiatives, including Partners in Flight and the North American Bird Conservation Initiative. Further, it provides a regional context for National Parks in their conservation and management of habitat for rare avian species.

Soil Respiration Trends Within and Among Stand Ages and Types in the Chequamegon National Forest

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Soil respiration is the amount of carbon that effluxes from living roots and microbiota in the soil. It is an important component of the forest carbon budget and has been studied in a wide range of ecosystems. The Landscape Ecology and Ecosystem Science (LEES) lab at the University of Toledo (formerly at Michigan Tech University), has been studying soil respiration in the Washburn District of the Chequamegon National Forest since 1999. This presentation will introduce the topic of soil respiration, discuss our previous work, report results from summer 2002, and present future directions for soil respiration work in the region. Soil respiration is often influenced by soil temperature (T_s), soil moisture (M_s), and vegetation. Micrometeorological and vegetative characteristics often vary by patch age and type. To assess these influences on soil respiration, we measured soil respiration rate (g C m^{-2} hr^{-1}), soil temperature (Ts; at 5-cm), and soil moisture (Ms; top 10-cm) across age-classes of red pine *(Pinus resinosa)*, jack pine *(Pinus banksiana)* and mixed hardwood (predominantly *Acer saccharum*, *Quercus rubra L.*, and *Betula papyrifera*) and in mature, mixed-conifer-hardwood ecosystems. Age-classes are roughly characterized as young (0—12 years), intermediate (13—25 years old), and mature (>25 years). We also made measurements in open-canopy areas: recent, prescribed burn (May 2002); recent clearcut (<1-yr old); clearcuts regenerating with hardwoods or pines (<10-yr old); and the Moquah pine barrens. Of the densely vegetated sites, young and intermediate red pines and Moquah pine barrens have the smallest soil respiration rates (0.23, 0.27, and 0.26 g C m^{-2} hr^{-1}, respectively). Young and mature jack pine and hardwoods had the greatest soil respiration rates, which were approximately 6% greater than the intermediate red pines (0.31 to 0.35 g C m^{-2} hr^{-1}). Intermediate jack pines, intermediate hardwoods, mature mixed, and mature red pine sites had respiration rates between these extremes. Vegetative characteristics seem to exert greater influences than T_s and M_s. Results from the open-canopy sites suggest that clearcutting does not necessarily mimic fire in its effect on soil respiration. The recently burned soils respire 30% to 46% less carbon than soils containing regenerating pines or hardwoods, respectively, and 45% less than soils of recent clearcuts. This data and future studies will focus on calculations of net ecosystem exchange of carbon at the landscape level; partitions of above- and ground-level carbon fluxes; and models of diurnal, seasonal, inter-annual, and long-term soil respiration.

Monitoring Natural and Anthropogenic Change in the Grand Sable Dunes, Pictured Rocks National Lakeshore

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Over the past 15 years, studies of lake-edge beach ridges along the upper Great Lakes have revealed a "quasi-periodic" pattern of lake level change during the late Holocene (less than 5,000 years). According to these models, 30-year periodicities of lake level variation of about 0.5 m are superimposed upon 150-year periodicities of lake level variation of about 1.5 m. These findings have stimulated research into relationships between lake level history and behavior of both perched dunes and foredunes. These dune histories suggest repeating cycles of dune building and dune stability, mediated by lake level. The life cycle of Pitcher's thistle *(Cirsium pitcheri)*, a monocarpic perennial, reflects evolutionary adjustment to these cycles. The species requires episodic dune disturbance (generating patches of high light environment and bare mineral substrate required for germination) and dune quiescence (permitting maturation of seed-bearing plants over 8-10 years). Since the Grand Sable Dunes, west of Grand Marais, Michigan, comprise the sole population center for Pitcher's thistle along Lake Superior's south shore, the status of the dynamic lake/dune/thistle system here is of interest. A population study of *Cirsium pitcheri* in the early 1990s revealed viable numbers of all life-stages in several geomorphic settings, suggesting a more or less "naturally functioning" system. Recent studies of Lonesome Point, east of the Grand Sable Dunes, however, suggest that a breakwater, built near the turn of the 20th century at Grand Marais and greatly enlarged in the 1950s, may be interfering with long shore drift, thus altering the behavior of the bluff at Lonesome Point during fluctuating lake levels. If this is occurring at Lonesome Point, then the buildup of littoral sediment updrift from the breakwater may be altering the manner in which the Grand Sable Dunes behave during lake-level change. Vegetation surveys along the bluff crest in 1988, 1991, 1996 and 1999 show that the historic high water levels of 1986 on Lake Superior did not produce the expected pulse of dune building. While these observations can be explained in several ways, they point up the high priority of monitoring for disturbance-adapted plant species along the bluffs lakeward of the Grand Sable Dunes.

Control of Purple Loosestrife at St. Croix National Scenic Riverway: A Question of Efficacy.

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National Park Service staff members have been attempting full control of purple loosestrife *(Lythrum salicaria)* since 1986 at St. Croix National Scenic Riverway (Riverway). Surveys are conducted on 227 miles of river each year. All plants found are counted and the number of stems and location recorded while applying control measures. Methods of eradication have been either complete removal of all vegetative parts or the application of Rodeo® (glyphosate) while simultaneously removing and bagging flower and seed heads. Records are kept on individual sites including the number of plants and stems, flowering stage and method of control used. This study looks at the effectiveness of these control measures within the Riverway. Known sites have increased from 2 in 1986 to 148 in 2002. Detailed records of the number of plants and stems began in 1993. The number of plants have increased from 621 plants in 1993 to 1296 plants in 2002. Despite the increased number of sites and plants within the Riverway, individual site histories show complete eradication over time in most cases. It appears that both vegetative removal and the application of herbicide are effective in these control efforts. Known populations outside the park's boundaries are thought to be the main source for continuing infestation within the Riverway. A secondary source is likely to be populations that continue to be overlooked.

The Use of Computer Simulation Modeling as a Tool for Planning and Monitoring in Wilderness Management at Isle Royale National Park

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Isle Royale is in the process of developing a Wilderness and Backcountry Management Plan (WBMP) in which visitor carrying capacity and campground crowding have emerged as a primary issue. Through visitor surveys and field observations, Isle Royale determined that in July and August 8-25% of visitors per night double up in campsites because of over-capacity use of campgrounds. This frequency of overcrowding has significant impacts on visitors' experiences as well as impacts on resources in a wilderness park. Identifying this problem was the first step; however, identifying effective and publicly acceptable solutions is more challenging. In 2001 the University of Vermont worked with NPS staff to develop a computer model to simulate visitor travel patterns in the park, creating a means to test the implications of existing and hypothetical conditions. With this tool, Isle Royale has explored the effectiveness of redistributing visitors temporally and spatially, altering campground capacities, increasing or decreasing visitation to the park, and establishing different tolerances for campground overcrowding. This model has aided the planning team in drafting viable alternatives for the WBMP. It has provided detailed information to the public about the implications of different options for improving conditions in the park's wilderness and backcountry, which has facilitated thoughtful public involvement in the planning process. After completion of the WBMP, this simulation modeling will continue to be a valuable tool for long-term monitoring. This modeling work could easily be applied to other parks with recreation management concerns.

Monitoring for Change in Plant Community Composition in Apostle Island Wetlands, 1996-2002.

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Wetlands are not common along the shores of Lake Superior and they occupy only a small portion of the total coastline. However, when compared to terrestrial habitat, wetlands are of major biological importance relative to their area. In addition, the coastal wetlands of Lake Superior are unique among Great Lakes wetlands in that they are dominated by peat substrates, unlike the mineral soils in wetlands of the lower lakes. Due to their high quality, coastal wetlands of the Apostle Islands National Lakeshore (APIS) are particularly interesting. Island habitat, in general, has been gaining attention from the conservation community since their insular properties have generally resulted in relatively less disturbance and, more importantly, a natural protection from invasion of aggressive exotic species. Conversely, coastal wetlands adjacent to the mainland in the Chequamegon Bay area such as Sioux River and Fish Creek Sloughs of Bayfield County, WI and Allouez Bay near the town of Superior, WI are all experiencing considerable change from peatland bogs to marshes, due to factors such as increased sedimentation from upland sources and the concomitant increase in the abundance of aggressive marsh species like narrow-leaf cattail *(Typha angustifolia)*. There is a need for ongoing vegetation monitoring of the island wetland habitat to detect changes from peatland to marsh where it is most likely to occur. Most existing broad-based monitoring programs do not succeed in this regards. We have begun a small-scale, workable monitoring program for wetlands of APIS. This monitoring program includes assessing potential change at a number of different spatial scales, including aerial photo analysis to delineate marsh and wiregrass with GPS and monitoring permanent sampling quadrats in the field. This approach has been incorporated across the spectrum of wetlands of APIS including sandscapes (Long Island), Great Lakes poor fen habitat (Stockton, Outer, and Michigan Island lagoons), and inland bogs (Devils, Sand, Stockton, and Outer Islands). The project objectives were to describe the wetlands through mapping wetland vegetation communities, describe species composition within these communities, and to establish long-term vegetation monitoring plots in the same wetlands. Specifically we:

1. mapped vegetation types in the wetlands using aerial photography and site visits for ground truthing;
2. characterized species composition in cover-types;
3. established, sampled, and geo-referenced long-term monitoring transects.

One of the wetland sites (Long Island) has now been sampled repeatedly, first in 1996-97 and for the second time in 2002. On several of the *Sphagnum*-dominated locations sampled on Long

Island, we have noticed the community did not change perceptibly during the 5 year period; hence, total species composition in these transects may not require sampling any sooner than once in 8 to 10 years. There were, however, small scale changes in these transects, such as increases in broad-leaf cattail *(Typha latifolia)* during the high water year (1996) and a subsequent decrease in the lower water year (2002). Reverse patterns were seen with other taxa. Other transects placed in the developing interdunal pools of Long Island and along the sand cut areas that were created by the Edmund Fitzgerald storm of 1976, showed a notable increase "pulse" of shrub species and a decrease of floating leaf and submergent species following the water level drop between the two sampling years. No discernable increase in aggressive emergent species was seen, except for an increase in purple loosestrife in one of the transects of the sand cut area. We recommend that photographic mapping and GPS map unit delineation be conducted every 20-25 years, depending on the observations made during transect monitoring.

Effects of Moose on Fuel Load in Isle Royale National Park Forests

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Moose-plant interactions have altered successional patterns of forests in Isle Royale National Park. Moose browsing may have altered the vegetation sufficiently to prevent spread of forest fires by reducing the fuel load. We used FIRELINK, a gap model derived from LINKAGES, to simulate forest cover types on Isle Royale, compared FIRELINK predictions to measurements of basal area, stem density, and fuel loading, and compared forest development and fuel loading with and without moose browsing in different cover types on Isle Royale. Age of stands and species composition were used to predict forest characteristics from the early 1900s when moose arrived on Isle Royale through 2050. FIRELINK predictions were similar to measured values in different cover types. In young cover types which had a large deciduous component, FIRELINK predicted that moose browsing reduced forest productivity. Fuel loading was affected less than productivity. In older forest stands established before moose arrived on Isle Royale, basal area in FIRELINK was relatively constant in simulations without moose, while basal area gradually declined if moose were present. FIRELINK simulations predict that over the next 50 years, from 2000 to 2050, the fuel load will not increase in most cover types on Isle Royale. Comparison of FIRELINK simulations with and without moose browsing suggested that the fuel load patterns of forests before moose arrival in the early 1900's were due to aging of the existing forest, rather than due to moose browsing effects.

Evaluating Aircraft Mounted, Aerial Imaging Systems for Identifying Groundwater Sources

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In 2000, the Ashland Office of Fishery Resources contracted A.W. Research Laboratories, Inc. of Brainerd, Minnesota to conduct an initial test-study of the effectiveness of aerial imaging in locating and identifying groundwater upwellings along about 35 miles of Lake Superior shoreline and along about 80 miles of tributary stream corridors. The study focused on testing the utility of imagery based on the differences in temperature, conductivity, dissolved solids and bottom type between groundwater sources and the surrounding ambient waters. Imaging included 35 mm photography for both visible and near infrared. We also used hyperspectral video to collect signatures for thermal and chlorophyll a. The system correctly identified more than 80% of the known groundwater sources. Incidental to the study, a large number of leaking or malfunctioning septic systems were identified and a number of point and non-point pollution sources were noted.

Water Use Efficiency in a Managed Northern Wisconsin Landscape: Variation among Ecosystems

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Ecosystem water use efficiency (WUE_E) of five different ecosystems (mature mixed hardwood (MHW), mature red pine (MRP), pine barrens (PB), young mixed pine (YMP) and recent hardwood clear-cut (CC)), was estimated in a managed Northern Wisconsin (USA) landscape for a full growing season using the eddy-covariance method. The variation of WUE_E in individual ecosystems was best explained by changes in vapor pressure deficit and soil moisture at 30 cm. While WUE_E seems to respond more to the variation in carbon than in water flux, the importance of taxon-specific structural restrictions imposed on water transport should not be underestimated. Furthermore, the role of hydraulic conductance may increase through ontogeny. On average, WUE_E was higher in the mature than in the younger, more recently disturbed stands. Most of the recovery in WUE_E following disturbance occurs during the first 10-20 years, quickly reaching levels comparable to mature stands.

Confirmation of a Resident Cougar at Sleeping Bear Dunes National Lakeshore in Northwest Michigan

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Field investigations were conducted from October 2001 through June 2002 to determine the presence/absence of resident cougars *(Puma concolor)* at Sleeping Bear Dunes National Lakeshore. The study was prompted by the area's long history of cougar sighting reports. It was part of an ongoing, joint project of the Michigan Wildlife Conservancy and Central Michigan University's Department of Biology to examine the status of the state-listed endangered species in both the Upper and Lower Peninsulas of Michigan. In 2001, the Wildlife Conservancy trained a field crew to identify cougar signs including tracks, scats, and cougar-killed deer. The crew subsequently located cougars in several areas of Michigan. At the Lakeshore, the field crew was assisted by two volunteers with many years of experience examining cougar sign in Oregon and Utah. About 45 person-hours were spent searching for cougar signs on seven dates in October, November, December, May, and June in the National Lakeshore. An additional 20 person-hours were spent on nearby private lands within five miles of the Lakeshore border. Searches usually involved two persons walking trails, sandy roads, or the foredune along Lake Michigan. Scats consistent with cougar droppings in size, shape, and content were collected and frozen for later DNA analyses. In late October, one clear and distinctive cougar track was found in clay on private land about three miles east of the southern part of the Lakeshore. Two scats morphologically consistent with cougar scat were found in association with the track. Preliminary analyses of microsattelite DNA from one of the scats yielded a genotype consistent with cougar. In November and December, cougar tracks were found by the volunteers in two locations in the southern part of the National Lakeshore. In May, several scats morphologically consistent with cougar scat were collected in the same general area. Searches in June yielded no tracks and only a few suspected cougar scats. However, an apparent cougar-killed deer was found in the central part of the National Lakeshore. On June 20, one member of the field crew clearly observed an adult cougar about ½-mile from the carcass. The animal was running at an angle toward the observer through a sparse pine stand and passed within about 30 yards. All distinguishing characteristics of the cougar were clearly visible for more than five seconds. The periodic findings of signs and the sighting of an animal over an eight-month period indicate the National Lakeshore is part of the home range of at least one cougar (probably two). Additional field studies are planned for March through June of 2003. Various genetic analyses of fecal DNA will also be conducted.

Inventories of Amphibians and Turtles in the Upper Midwest via USGS's Amphibian Research and Monitoring Initiative and NPS's Inventory and Monitoring Program

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Declines of populations of amphibians remain a major concern to conservation biologists. Amphibians can be sensitive indicators of environmental stress and their declines could also indicate significant ecological effects on other organisms. We know little about the statuses of most populations of amphibians or whether any local or universal environmental stressors are reducing their persistence over time. The Department of Interior's Amphibian Research and Monitoring Initiative (ARMI) was created to help address these deficiencies. The U.S. Geological Survey (USGS) has primary responsibility to execute this program. ARMI calls for an integrated approach that uses information obtained over a range of geographical, temporal, and spatial scales. The goals are to establish baseline information, and to describe trends and cause-and-effect relationships regarding any declines, for populations of amphibians nationally. Ultimately, ARMI is expected to provide managers and policy makers with comprehensive data that are comparable across regions and meaningful in use. In 2002, we began executing the core of ARMI in the upper Midwest. Our principal objective was to survey for the presence and relative abundance of several species of amphibians living in at least three areas managed by the Department of Interior. We initiated studies in the Upper Mississippi National Wildlife and Fish Refuge Complex (Refuge), the St. Croix National Scenic Riverway (Riverway), and Voyageurs National Park (Voyageurs). Our efforts in the Riverway and Voyageurs were part of an ongoing joint effort with the National Park Service's Inventory and Monitoring Program that also includes inventories of reptiles. We sampled amphibians in randomly selected 25-ha blocks of habitat in each management unit with known areas of inference. We conducted standardized visual and call surveys, and measured a variety of other biotic and abiotic variables, at all potential amphibian breeding sites associated with those blocks. We also screened animals for diseases, evaluated deformities, and analyzed water quality for a small number of these sites in collaboration with the Water Resources Division and National Wildlife Health Center of USGS. We surveyed 30, 23, and 24 habitat blocks 25-ha in size for amphibians in the Refuge, Riverway, and Voyageurs, respectively, and 82, 86, and 69 potential breeding sites associated with those blocks. We located 9, 12, and 11 species of amphibians living in each of these areas. We observed northern leopard frogs *(Rana pipiens)* most often at sites in the Refuge, green frogs *(Rana clamitans)* most often at sites in the Riverway, and wood frogs *(Rana sylvatica)* most often at sites in Voyageurs, although several species were common to all three management units. Based upon a limited effort in 2002, we also located common snapping *(Chelydra serpentina serpentina),* western painted *(Chrysemys picta bellii),* wood *(Clemmys insculpta),*

common map *(Graptemys geographica)*, and spiny softshell *(Apalone spinifera)* turtles in the Riverway and common snapping and western painted turtles in Voyageurs.

Spatial and Temporal Change in Surface Water Quality, Upper Great Lakes

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In 1979, we began intensive monitoring of surface water at the Calumet watershed adjacent to Lake Superior's south shore. Our objectives were to quantify how snowpack SO_4^{2-} and NO_{3-} content and depth of snowmelt flow in forest soils alter spring stream water chemistry. That year we also began seasonal surveys of stream, precipitation, snowpack, canopy throughfall, and stemflow chemistry at Isle Royale National Park and Pictured Rocks National Lakeshore to see how forest canopy and surface soils modified precipitation chemistry before it reached the stream. Following completion of lake and stream chemistry surveys on Isle Royale and throughout Michigan's Upper Peninsula, we selected two small watersheds (Wallace Lake watershed on Isle Royale and Little Beaver watershed at Pictured Rocks National Lakeshore) for an inventory and long-term monitoring of ecosystem processes. During 1983-85, intensive monitoring of surface water quality in small watersheds located in Voyageurs, Apostle Islands, Sleeping Bear, Indiana Dunes, and Cuyahoga Valley was also conducted for a total network of seven national parks. The objective was to see if surface water chemistry was altered by the large gradient of atmospheric SO_4^{2-} and NO_{3-} deposition in the region. Currently monitoring and research continues at Wallace, Sumner Lake, and Calumet watersheds. Through early intensive study of a few key sites, we were able to quantify natural sources of variation in surface water solute concentrations and budgets (inputs, outputs), and design the more extensive monitoring in the Upper Great Lakes parks. Surface water in most national parks of the Upper Great Lakes is moderate to well buffered due to alkaline glacial till brought south from James Bay, and locally from exposed Cambrian sedimentary bedrock. In contrast, where glacial outwash prevails, as at Trout Lake in Pictured Rocks and the Kingston Plains, surface water is dilute and chemically sensitive. Stream water chemistry at Calumet and Wallace show few time trends and provide an estimate of baseline conditions. However, both Calumet and Wallace have recently entered a period of high variation in hydrology, snowpack, and nutrient budgets. The driver appears to be warming temperatures in November. Twenty years ago mean daily November temperatures were -5° C at Wallace Lake. Today, mean temperatures are at or above zero. Under a snowpack, soils remain thawed and many biological processes continue throughout winter. Such processes regulate the amount and quality of dissolved organic carbon (DOC) and nitrogen (DON) entering streams and lakes. With snowmelt, there is a sharp increase in the export of DOC, DON, phosphorus, and inorganic N (NO_{3-}) to streams and lakes. Change in any of these solutes will affect aquatic production and biodiversity. By quantifying change in surface water chemistry, we can judge better the sensitivity of above and below ground and aquatic biological components to climate change. The base cations, such as Ca^{2+} and Mg^{2+}, along with carbonates and silica, serve well in separating relative contributions of precipitation and ground water to water budgets.

Such shifts can occur with climate change. Stream water K^+, NO_{3-}, DOC and DON are sensitive indicators of change in terrestrial and aquatic processes, and the hydrologic flow path to the stream or lake. Change in their seasonal concentrations may also be a response to atmospheric inputs and climate change.

Restoration of Oak Island Sandscape, Apostle Islands National Lakeshore

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Apostle Islands National Lakeshore, located in northwestern Wisconsin, has the most diverse collection and among the highest quality sandscapes or coastal features (sand spits, cuspate forelands, tombolos, barrier spits) found in the Great Lakes. Sandscapes are very popular visitor use areas within the park - they are accessible, very scenic and have sandy beaches. Sandscape vegetation, however, tends to be easily impacted by human trampling. Results of ten years of monitoring conducted by the park's natural resource staff on the Oak Island sandscape indicated an increase in non-native species and bare ground and a decrease in plant cover. To try to reverse these trends, the park has been working with the Natural Resource Conservation Center (NRCS) with funding provided by both the U.S. Fish and Wildlife Service and National Park Service to restore this important and fragile sandscape. Beginning in 2000, plant materials were gathered from Oak Island sandscape and propagated at the NRCS's Rose Lake Plant Materials Center. In 2001, plots were established to determine how well various species transplanted. In May 2002, nearly 3,500 propagated plants were planted with the assistance of a Northland College ecology class. Monitoring plots were established to determine the effectiveness of restoration, including plantings and exotic species control.

Diversity of Carabid Beetle Assemblages in Selected Habitat Types within Grand Portage National Monument, Cook County, Minnesota

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Forest researchers in North America and Europe have studied ground beetle (*Carabidae*) species diversity as indicators of environmental disturbances. These disturbances range from dramatic (clear-cutting) to subtle (atmospheric pollutant deposition). Carabids were sampled at seven sites within Grand Portage National Monument to obtain a baseline species list for the park, to determine diversity of beetle assemblages across sites, and to evaluate disturbance history of sampled sites. The vegetation communities selected for sampling ranged from a saturated margin of an ancient beaver pond to an arid exposed ridge top (Mt. Rose), and included a site believed to have been used as fields or pasture (meadow) for more than 200 years. The remaining four sites were within the mixed hardwood-conifer forests typical of the northern Great Lakes region. Based on the species and size of canopy trees, each of these four sites was believed to have a slightly different disturbance history. Arrays of four trapsets were placed about 10 meters apart in each site sampled. Each trapset consisted of a 1-m plexiglas barrier with a pitfall trap on each end. Pitfalls were charged with 50 ml of propylene glycol as a preservative and opened for one-week periods in June, July, August and September. All carabids were retrieved, washed to remove preservative, mounted and identified to species. Plant communities were described by sampling a representative 10-m square plot within each sample site. Both live and standing dead trees greater than 6.5 cm DBH were recorded by species and DBH, and shrubs greater than 1.5 cm DBH were enumerated by species. Percent cover was estimated for herbaceous plants and litter within a 1-m square subplot in the corner of the larger sample plot. Principle components analysis (PCA) was performed on the beetle species and the vegetative characteristics of the sample sites and the results plotted on three dimensional axes (ordination) to help visualize the differences among the sample sites. A total of 1,480 carabid beetles were collected, representing 12 genera and 33 species. Based on available references, five species were new to Minnesota, including *Pterostichus atratus*, representing a range extension from Pelee Island in Lake Erie. *Pterostichus melanarius*, an introduced species, was the most abundant ground beetle species (641). Although present in all sites except the beaver pond margin, the number of individuals collected increased with the suspected site disturbance history. *Platynus decentis*, a native species and the second most frequent capture (258), exhibited the reverse correlation; the numbers were higher on sites having the least disturbance. The highly disturbed sites (Mt. Rose and meadow) were clearly separated from all forested sites, and each other, in the ordination based on relative abundance of the nine most abundant beetle species. Ordinations based on the vegetation community characteristics were less easily interpreted. Differences in species present and their abundance may reflect the effect of microclimate on ground beetle habitat, which may be related to factors not addressed in the

current sampling design. Several assemblage features (number of introduced vs. native species, individuals abundant vs. uncommon) characterize the differences among the sites and appear to be related to disturbance history.

A Population and Angler Use Assessment of Muskellunge in Shoepack Lake, Voyageurs National Park, Minnesota

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Shoepack Lake in Voyageurs National Park, Minnesota, supports a genetically unique population of muskellunge (*Esox masquinongy masquinongy*). We are studying population characteristics and angler use of muskellunge in Shoepack Lake to evaluate their long-term viability. After the second year of a multiple mark-recapture study, we estimated the mean adult population size to be 1197 fish (95% confidence interval=1016-1457). The majority of captured fish were between 500-750 mm, with the largest measuring 820 mm and the smallest measuring 381 mm. The sex ratio of captured fish was 265 females to 486 males with 48 unidentified fish. Angler surveys (n=63) collected from the months of May to September revealed a total catch rate of 0.2227 fish per angler per hour in 2001 and a total catch rate of 0.3010 fish per angler per hour in 2002. Anglers harvested few fish (~0.6%) partly because only 3.6% of captured fish were above the 762 mm minimum length. We are currently analyzing samples for age structure, back-calculated growth, and length- and age-specific fecundity. We plan to estimate the effective population size of Shoepack Lake muskellunge, and evaluate future population scenarios using virtual population analysis and population viability analysis.

Recent Large Landslides in the Sleeping Bear Dunes National Lakeshore, Michigan

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Coastal bluffs and beaches have slid into Lake Michigan many times in the Sleeping Bear Dunes National Lakeshore. The USGS collaborated with the NPS to study two recent slides to improve the understanding of environmental effects and triggering mechanisms of landslides in the Park. In February 1995, approximately one million cubic meters of sand at Sleeping Bear Point slid into deep water offshore, removing a 500-m-long, 60-m-wide beach that changed a gently sloping lake bottom into a sharp 20-m drop off near the shore. Side-scan sonar and seismic reflection surveys in 1997 mapped the offshore extent of the slide. These surveys revealed that numerous slides have occurred for centuries at Sleeping Bear Point, disrupting 5 sq km of the bottom of Lake Michigan. In June 1998, a 90-m high bluff failed and rushed out into Lake Michigan at Pyramid Point. Onshore mapping days after the Pyramid Point Slide, and ground penetrating radar surveys and monitoring of pore water pressures beneath the bluffs at Sleeping Bear Point, suggest that groundwater played a key role in triggering both these slides by increasing pore water pressures within the bluff. High pore pressures lessen the forces holding sand grains within the bluff together and may weaken the bluff enough to trigger a slide. Ancient buried channels underlie at least one of the landslide zones and control local hydrologic conditions and slope stability. Underwater surveys and onshore monitoring provide information that USGS and NPS scientists can use to evaluate the hazard posed by landslides to National Lakeshore visitors and to coastal resources. Additional pore water pressure monitoring and ground penetrating radar surveys are needed to better understand landslide hazard within the park.

High-resolution Multibeam Sonar Mapping of Lake Trout Spawning and Nursery Habitat

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Like all large lakes, the composition and shape of the lake floor of Lake Superior reflects the processes that shape its formation today as well as in the past. Maps of the lake floor made with traditional echosounders lack the resolution to permit scientists to read the subtle "fingerprint" of these processes preserved in the lake-floor. The advent of modern, high-resolution multibeam sonar has revolutionized the mapping of the sea-floor.

In a traditional echosounder, the depth to the lake-floor below the ship is measured by timing how long it takes for an acoustic ping to travel to the lake-floor and back to the ship. The longer the delay, the deeper the lake floor is. This type of surveying provides high resolution bathymetric information along the trackline followed by the survey boat. Nothing is known about the lake floor either side. High-resolution multibeams use a fan of acoustic beams (over 100) to measure the shape of the lake floor along a "swath". By sailing a series of overlapping swaths, it is possible to achieve complete coverage of the lake floor at high resolution. Backscatter information can be collected simultaneously with the bathymetric data by the multibeam. This can be used to create a sidescan-image of the lake-floor that can be used to characterize the composition of the lake-floor

Multibeam sonar surveys will be acquired this summer as part of a project to characterize lake trout spawning and nursery habitat in the Apostle Islands. The project will combine an expansive database collected with high resolution remote sensors of substrate, fish size, fish density, plankton abundance, current speed, current direction, water depth, and temperature with traditionally collected data of each variable that ground truth remotely sensed data and provide biological data from various sites on each shoal. We will construct and analyze a high-resolution Geographic Information Systems (GIS) database of the remotely sensed and site sample data. A description of the planned work in the Apostle Islands will be presented together with results from a pilot study recently conducted on Gooseberry Reef on the Minnesota North Shore.